EPA Response to July 24, 2017 EPA/CPG Meeting
LPRSA BERA Discussion Action Items

After a July 24, 2017 meeting with CPG, EPA committed to supplying additional information and direction to the CPG, and to review supplemental information submitted by CPG for clarification of the October 2016 LPRSA Revised Draft BERA.

EPA committed to review several draft text sections which the CPG plans to include in the Revised Draft BERA, and to give direction for some of the items brought up during the meeting, which were also enumerated in CPGs 8/8/17 meeting follow-up memo (titled: EAP-CPG Meeting BERA ACTION ITEMS July 24, 2017):

1. Salinity Zones – On 8/15/17 CPG emailed a salinity zone memo (from Windward Environmental to de maximis dated 8/11/17, subject: Response to 2016 Draft BERA comments: salinity zones). The memo was reviewed by EPA and found to be acceptable.

2. Mullica River freshwater SQT – On 8/11/17, CPG sent a memo (pdf file titled: 20170810 Proposed Mullica freshwater text to EPA) with proposed BERA text to describe the use of freshwater SQT data from the Mullica River in the revised BERA. The text was reviewed by EPA and found to be acceptable.

3. Background/Reference data – On 8/11/17, CPG sent a memo (from Windward Environmental to de maximis dated 8/10/17, subject: Response to 2016 Draft BERA comments: background/reference dataset agreements). The memo was reviewed by EPA and found to be acceptable.

4. SQT Multivariate Statistical Approach – On 8/11/17, CPG sent a memo (pdf file titled: 20170810 BERA multivariate approach to EPA). The memo listed the proposed revisions to the steps used during the multivariate SQT analysis in the BERA. Review of the memo and further review of the BERA SQT analysis resulted in three issues that should be addressed. EPA anticipates a call or meeting with the CPG to discuss the information provided:

    a. Multiple Regressions: EPA notes that most of the proposed multiple regression analysis was well described and consistent with previous recommendations. However, one aspect of the proposal should be modified to eliminate the dependence on stepwise regression methods which are known to perform poorly when interpretation of the regression model is the primary objective.

    Rather than stepwise regression followed by regressing residuals on chemistry data, a more robust approach following standard statistical practice would include specification of *a-priori* models (likely including all habitat variables) with a test for the degree of model improvement with addition of chemistry variables.

    Several types of tests are available including use of Type III tests: Akaike criteria for model selection; predicted residual sum of squares (PRESS) statistics based on drop-one

cross-validation; or just multiple degrees-of-freedom tests of significance, by comparing full and reduced models, including or excluding chemistry variables.

Tests of the importance of chemistry variables should be based on Type III sums of squares, which are a rigorous way of accounting for other variables in the model. This is what CPG seems to be trying to do through regressing on residuals. The regression of residuals on chemistry data or *vice versa* is an *ad-hoc* way of simulating the more statistically rigorous Type III tests which account for all variables in the model.

There are few habitat variables, so model reduction is probably not necessary. For example, one could fit the habitat model with chemistry variables termed the full model. Then, fit the reduced model including habitat, but excluding chemistry. Finally, an F test (https://onlinecourses.science.psu.edu/stat501/node/295):

$$F^* = \left(\frac{SSE(R) - SSE(F)}{df_R - df_F} \right) \div \left(\frac{SSE(F)}{df_F} \right)$$

There are metrics for evaluating the degree to which chemistry improves model fit after adjusting for habitat, but in general, EPA recommends that stepwise regression by p-values be avoided. Other options are available, but there are a relatively small number of habitat variables, so leaving non-significant predictors in the model is unlikely to cause substantive problems. Particularly because the Principal Component scores are statistically independent, so regression estimates should not change greatly when non-significant variables are maintained. Also, removal of variables implies that non-significant variables have no contribution, whereas maintaining non-significant variables left in the model have non-zero coefficients which are the best fit to the data, and so are more consistent with the data than zero coefficients.

EPA suggests a conference call on the details of how best to specify a small number of *a priori* models and how to evaluate them. Also EPA recommends that CPG refer to the following notes on model building (http://biostat.mc.vanderbilt.edu/tmp/course.pdf; a shortened version of the text book by Harrell on this topic), to help avoid common pitfalls.

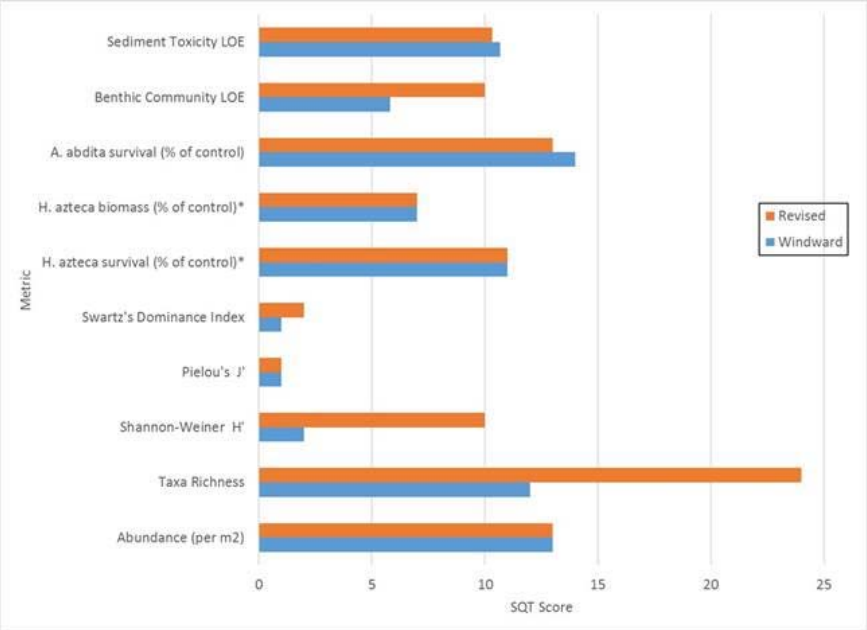
b. SQT Replicate Statistics: CPG's SQT assessment included statistical handling of replicate benthic invertebrate community (BIC) data. During the review of the Draft BERA, EPA found some discrepancies in the reported BIC metric values (e.g., taxa richness, Shannon-Wiener, Simpson's, and Pielou's Evenness) compared to those that had been derived previously for the Lower 8.3 Mile in the Focused Feasibility Study (FFS). For the 17-mile BERA, CPG calculated metric values on the individual replicates and then averaged to estimate station metric values whereas in the FFS, the replicates were averaged first and then the metrics were calculated. Averaging first is more appropriate. The CPG approach will tend to underestimate metric values (particularly noticeable for taxa richness where different taxa are identified in the replicates). Because this appeared to be minor compared to the significant concerns identified in EPA's comments to the BERA, EPA did not include a comment with the 6/30/17 BERA comments. However, EPA subsequently reviewed the SQT Data Report for the Lower 8.3 Mile, which included metric calculations based on averaging replicates first. To

maintain consistency, and to avoid underestimating metric values, the calculations should be revised.

c. Jamaica Bay Reference Locations: CPG's SQT screening for Jamaica Bay identified 31 acceptable stations but didn't include the 2003 REMAP program results, which generated an additional four acceptable stations. EPA has re-scored the LPRSA estuarine stations using the revised Jamaica Bay reference envelope, and a summary of the comparison is provided below. In the table, the "count" is the number of LPRSA estuarine stations that score outside of the Jamaica Bay reference envelope (based on the Draft BERA or the revised dataset that includes the alternative handling of replicate data); the "percent" is the ratio of the number of stations outside of the envelope divided by the total number of stations (27). The "percent difference" values were calculated as the difference between CPG's scoring and revised scoring results divided by the CPG result. Note that the *Hyalella* toxicity endpoint results were included in total sediment toxicity level of effort (LOE) calculations although these values were not associated with Jamaica Bay. The Shannon-Weiner diversity metric is most sensitive, followed by taxa richness (Percent Difference = 400% compared to 100% for both taxa richness and Swartz dominance). There was little impact on the toxicity LOE (Percent Difference = 3%) due in part to the use of the same values for two of the three LOEs but Percent Difference for the *Ampelisca* 10-day survival endpoint was small as well. There was no change to the chemistry leg of the triad.

The weight of evidence (WOE) Comparison worksheet (attached) shows the overall impact on the SQT classification for estuarine stations: the WOE conclusions for 5 of 27 stations would change – three stations classified as low impacts would change to medium impacts, and two stations would change from medium to high impacts.

Dataset	Statistics	Abundance (per m^2)	Taxa Richness	Shannon-Weiner H'	Pielou's J'	Swartz's Dominance Index	*H. azteca* survival (% of control)'	*H. azteca* biomass (% of control)'	*A. abdita* survival (% of control)	Benthic Community LOE	Sediment Toxicity LOE
Windward, 2016	Count	13	12	2	1	1	11	7	14	5.8	10.7
	Percent	48%	44%	7%	4%	4%	41%	26%	52%		
Revised (n=35)	Count	13	24	10	1	2	11	7	13	10	10.3
	Percent	48%	89%	37%	4%	7%	41%	26%	48%		
Windward, 2016 versus Revised	Percent Difference	0%	-100%	-400%	0%	-100%	0%	0%	7%	-72%	3%



5. Additional TRV Explanation (yellow) – On 7/31/17, CPG sent a memo (pdf file titled: 20170731 17-mi BERA TRV Explanation to EPA) containing a table with additional information requested by EPA in order to explain BERA TRVs that could not be verified by EPA (those color-coded yellow in EPA's 6/30/17 TRV spreadsheet which was attached to the EPA's 6/30/17 BERA comments). The explanations were reviewed to determine whether the CPG's alternative TRVs could be verified. Of the 15 TRVs in question, eleven were verified. The review findings are attached as Appendix A.

6. Additional TRV Explanation (blue) – On 8/3/17, CPG sent a zip file containing tables and printouts from the @RISK program used to develop species sensitivity distribution (SSD)-derived TRVs that could not be verified by EPA (those color-coded blue in EPA's 6/30/17 TRV spreadsheet which was attached to the EPA's 6/30/17 BERA comments). The printouts and data were reviewed to determine whether CPG's alternative TRVs could be verified. EPA is nearing completion of the review process, and will provide specific comments in anticipation of a conference call to discuss the findings.

7. Additional TRV Explanation (blue) – on 8/23/17, CPG sent a follow-up explanation of several TRVs that had been developed using the @RISK program, that were graphically depicted in the BERA but had been questioned by EPA because the line-of-best-fit did not appear to fit the data. The CPG checked the original calculations, found an error, and recalculated the line-of-best-fit and the associated TRVs. EPA is nearing completion of the review process, and will provide specific comments in anticipation of a conference call to discuss the findings.

8. Focal versus Non-Focal Species – The CPG asked for clarification on the use of the terms "focal species" and "non-focal species" within the BERA, specifically with regard to Comments 9 and 36 (from EPA's 6/30/17 comments on the Draft BERA). The concept of focal and non-focal species is only applicable to fish, and is the result of opportunistic sampling during the fish collection events. While it is a factor that should be defined in the BERA, the terms "focal" and "non-focal"

are used excessively in the document (180 times for focal and 38 times for non-focal). Given that each trophic group contains representative focal and non-focal species, comparisons of trophic status are more appropriate than the terms focal and non-focal. In most cases, the focal and non-focal species within a given trophic status show similar COPECs and risk estimates (within the same order of magnitude). The specific comments from EPA's 6/30/17 BERA comments follow:

> Comment 9 - *Revise the text to include all potential receptors, regardless of the focal vs non-focal classification. Further, regardless of focal/non-focal, these species should be identified based on trophic status (omnivore, invertivore, piscivore).* This comment is directed to the last sentence of the first paragraph of Section ES 6.3.2. The beginning of the paragraph categorizes the focal fish species based on their trophic status, but the last sentence does not treat the non-focal fish species the same way. Although the non-focal fish species are placed in the appropriate trophic status in the text below the first paragraph, it would be beneficial to revise the last sentence of the first paragraph to read: "Five non-focal fish species were also evaluated in the fish tissue assessment: benthic omnivore – common carp, invertivore – white catfish and white sucker, piscivore – northern pike and smallmouth bass."
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> Comment 36 - *The table should also include species that CPG has relegated to being non-focal. All ecological receptors should be included in the BERA.* This comment is requiring that Table 3-2 list the non-focal fish species, specifically for Assessment Endpoint 5 in the Selected Receptor Groups section. This line should have the non-focal species identified.

Appendix A: EPA's Response to CPG's Explanation of TRVs

EPA Review of - Explanation of TRVs (shaded yellow in EPA TRV attachment) in response to EPA comments dated 6/30/17

COPEC	NOAEL TRV from BERA	LOAEL from BERA	Reference[a]	Explanation of TRV Derivation[b]	EPA Comments
Benthic Invertebrate Tissue					
Dieldrin	478 µg/kg ww	4,780 µg/kg ww	Estenik and Collins (1979)	The LOAEL was derived from Table II, representing the tissue concentration of midge larvae immersed in 20 µg/L dieldrin for 2 hours; at this concentration, all larvae were moribund. No ACR was applied because the acute concentration is expected to be conservative (i.e., higher tissue concentrations would be expected after a longer exposure period). Values presented in paper are assumed to be dry weight (based on wording in the Materials and Methods Extraction Procedure section indicating "extract was evaporated to dryness") and were converted to wet weight assuming 80% moisture (23.9 µg/g dw = 4.78 µg/g ww)	EPA does not agree that these values are appropriate; further discussion is warranted. The 24hr LC50 for dieldrin was listed in the cited paper as 0.5 ug/L. The alternative LOAEL/NOAEL TRVs were developed based on an exposure concentration that was 40-fold higher than the 24hr LC50. The 2-hour exposure to 20 ug/L yielded a meaningless tissue value, as all of the exposed larvae were moribund; meaning they could no longer accumulate dieldrin, and likely had altered accumulation throughout the exposure due to the extremely high dose. Neither a LOAEL nor a NOAEL value can be derived from a test in which all of the exposed organisms died. The alternative TRVs are not scientifically defensible. EPA stands by the dieldrin TRVs developed for the Lower 8 Mile FFS.
Lead	4 mg/kg ww	40 mg/kg ww	Spehar et al. (1978)	The LOEC for the 28 day exposure of *G. psuedolimnaeus* to 32 µg/L lead nitrate is presented in Table 1. Corresponding tissue concentrations are presented in Figure 7 where 60% mortality was observed during the 32 µg/L treatment resulting in a concentration of ~190 µg/g dw in *G. psuedolimnaeus* tissue. Converting this value to wet weight assuming 80% moisture content results in a value of 38 µg/g ww, consistent with the value of 40 µg/g ww presented in the ERED database, which was selected as the TRV.	The TRVs selected from the cited paper were verified.
Silver	0.49 mg/kg ww	0.59 mg/kg ww	Naddy et al. (2007)	Figure 2A shows the NOEC and LOEC for the reproductive endpoint (total # of young) as 2.37 µg/L and 3.79 µg/L, respectively. Section 3.5 also points these values out as the NOEC. Figure 2B provides the Ag tissue concentrations, specified in dry weight, estimated to be ~2.5 and ~2.9 µg/g dw (0.50 and 0.58 µg/g ww, respectively, assuming 80% moisture). These wet weight values are similar to values presented in the ERED database (0.49 and 0.59 µg/g ww), which were the TRVs selected for use in the BERA.	The TRVs selected from the cited paper were verified.
Fish tissue					

COPEC	NOAEL TRV from BERA	LOAEL from BERA	Reference[a]	Explanation of TRV Derivation[b]	EPA Comments
Lead	2.5 mg/kg ww	4 mg/kg ww	Holcombe et al. (1976)	Table 3 reports a tissue concentration of 20.1 µg/g dw (4.02 µg/g ww, assuming 80% moisture) associated with decreased hatchability of embryos of the third generation brook trout embryos, which was selected as the LOAEL. The reported NOAEL is 12.7 µg/g dw (2.5 µg/g ww, assuming 80% moisture).	The TRVs selected from the cited paper were verified.
Fish diet					
Zinc	19 mg/kg bw/day	38 mg/kg bw/day	Takeda and Shimma (1977)	Table 1 reports a significant difference in weight gain between the control (Lot I: basal diet) and the highest treatment (Lot IV: basal diet + 2000 ppm Zn). The FIR was calculated as 1.9% of the average body weight (initial and final) presented in Table 1 for Lot IV (0.019 x 0.01375 kg = 0.00026 kg/day). The LOAEL TRV was calculated as the concentration in food times the FIR divided by the BW (2000 mg/kg x 0.00026 kg/day ÷ 0.01375 kg = 38 mg/kg bw/day). The NOAEL was calculated the same way using the Lot III concentration of 1000 ppm and the average body weights at this concentration.	The TRVs selected from the cited paper were verified.
Fish egg					
Total PCBs	25.8 µg/kg ww	258 µg/kg ww	Hµgla and Thome (1999)	Table 2 presents observed effects and PCB concentrations in eggs in dry weight. The LOAEL was determined to be 1289 ng/g dw based on significantly reduced hatching rate when food was laced with 12.5 µg/kg PCBs (258 ng/g or mg/kg ww, assuming 80% moisture). The NOAEL is the LOAEL/10.	The TRVs selected from the cited paper were verified.
Bird diet					
Copper	1.9 mg/kg bw/day	19 mg/kg bw/day	Jensen and Maurice (1978)	Table 2 presents effect of copper exposure on body weights. A significant difference from the control was observed in the BW at a dietary concentration of 250 ppm. A FIR of 0.044 kg/day was used based on data from NRC (1994). The LOAEL TRV was calculated as the concentration in the diet times the FIR divided by the BW (250 mg/kg x 0.044 kg/day ÷ 0.591 kg = 19 mg/kg bw/day), using the 4-week BW from Table 2. The NOAEL is the LOAEL/10.	The TRVs selected from the cited paper were verified.

COPEC	NOAEL TRV from BERA	LOAEL from BERA	Reference[a]	Explanation of TRV Derivation[b]	EPA Comments
Lead	5.5 mg/kg bw/day	28 mg/kg bw/day	Morgan et al. (1975)	Figure 2 presents a LOAEL of 500 ppm in the diet resulting in a significant decrease in body weight compared to the control. The BW was derived from the initial and final weights of Japanese quail at the 500 ppm dose (0.065 kg). The FIR of 0.0036 kg/day is based on the allometric equation for Galliformes from Nagy (2001). The LOAEL TRV was calculated as the concentration in the diet times the FIR divided by the BW (500 mg/kg x 0.0036 kg/day ÷ 0.065 kg = 28 mg/kg bw/day). Note that the BW and FIR were incorrectly presented in Appendix E and will be revised. The NOAEL was derived similarly from the dietary concentration of 100 ppm in the same study.	The TRVs selected from the cited paper were verified.
Selenium	0.42 mg/kg bw/day	0.82 mg/kg bw/day	Heinz et al. (1989)	Table 2 presents the selected LOAEL of 8 ppm in the diet, based on significantly reduced survival of ducklings compared to the control. The basal diet contained 0.1 to 0.2 ppm selenium, which was averaged to 0.15 and added to the 8 ppm diet (total of 8.15 ppm Se in diet). The BW used in the derivation was 1.145 kg, the average of the male and female control weights measured during the study (Table 1). The FIR was calculated as 10% of the body weight (0.1145 kg/day), based on Heinz (1987). The LOAEL TRV was calculated as the concentration in the diet times the FIR divided by the BW (8.15 mg/kg x 0.1145 kg/day ÷ 1.145 kg = 0.82 mg/kg bw/day). The NOAEL was derived similarly from the next lowest dietary concentration in the same study.	The TRVs selected from the cited paper were verified.
Mammal diet					

COPEC	NOAEL TRV from BERA	LOAEL from BERA	Reference[a]	Explanation of TRV Derivation[b]	EPA Comments
Arsenic	2.6 mg/kg bw/day	5.4 mg/kg bw/day	Hext et al. (1999)	Hext et al. (1999) is the incorrect citation and should be replaced with Byron et al. 1967. See Appendix E for details on TRV derivation from this study.	EPA does not agree that these values are appropriate; further discussion is warranted. Byron et al 1967 is not listed in the references for Appendix E. It is cited in the table, but no actual citation is listed. EPA cannot review this paper until it is cited properly, and a copy of the paper is forwarded to EPA. However, because arsenic was carried over from the SLERA, but was not determined to pose dietary risk to mammals using either the EPA's TRVs or CPG's alternative TRVs, it would eliminate the need for further discussion if the alternative TRV were dropped from consideration, and the Revised BERA only use the TRVs that the EPA supplied.
Mercury/methylmercury	160 µg/kg bw/day	250 µg/kg bw/day	Wobeser et al (1976b)	Table 1 presents the selected LOAEL of 1.8 ppm in the diet, based on reduced survival compared to the control. A basal concentration of 0.1 ppm was added to this dietary concentration based on Wobeser et al. (1976a) (total 1.9 ppm Hg in diet). The BW and FIR were 1.34 kg and 0.176 kg/day, respectively, derived from Bleavins and Aulerich (1981). The LOAEL TRV was calculated as the concentration in the diet times the FIR divided by the BW (1.9 mg/kg x 0.176 kg/day ÷ 1.34 kg = 0.25 mg/kg bw/day). The NOAEL was derived similarly from the next lowest dietary concentration in the same study.	EPA does not agree that these values are appropriate; further discussion is warranted. EPA maintains that the FFS TRV is technically defensible and appropriate for use in the BERA. The derivation of and rationale for the FFS TRVs for MeHg (NOAEL and LOAEL of 0.0165 and 0.027 mg MeHg/kg bw/day based on Wobeser et al., 1976a) is presented in the GLWQI water criteria document (EPA, 1995). The CPG argues that the 10-fold subchronic-chronic uncertainty factor applied in the GLWQI assessment is not justified and references a companion study (Wobeser et al., 1976b) that reported no clinical or pathological effects to mink fed contaminated fish (0.44 mg Hg/kg) throughout a 145-day period. EPA (1995) considered this second study in the development of the GLWQI criteria for methylmercury. Given the study design differences, including the fact that only total mercury was analyzed for in the second study, it was concluded that the results of the companion study support, rather than contradict, the FFS TRV and application of the 10-fold uncertainty factor. For reference, the estimated NOAEL dose from the second study (0.0495 Hg/kg bw/day using the 75% ration treatment and assuming 1 kg mink body weight and 0.15 kg/day food ingestion rate) is only 3-fold higher than the FFS TRV NOAEL (which includes application of the uncertainty factor) and only a similar factor less than the NOAEL derived from the Wobeser et al., 1976a study. EPA stands by the mercury/MeHg TRVs developed for the FFS.

COPEC	NOAEL TRV from BERA	LOAEL from BERA	Reference[a]	Explanation of TRV Derivation[b]	EPA Comments
Nickel	40 mg/kg bw/day	80 mg/kg bw/day	Ambrose et al. (1976)	Table 5 presents the selected LOAEL of 1000 ppm in the diet based on reduced body weight of weanlings compared to the control. The BW of 0.35 kg is an average adult weight for rats as presented in EPA (1988). The FIR of 0.028 kg/day is based on an equation presented in EPA (1988) for lab mammals based on BW. The LOAEL TRV was calculated as the concentration in the diet times the FIR divided by the BW (1000 mg/kg x 0.028 kg/day ÷ 0.35 kg = 80 mg/kg bw/day). The NOAEL was derived similarly from the next lowest dietary concentration in the same study.	EPA does not agree that the NOAEL value is appropriate; further discussion is warranted. The explanation says the NOAEL TRV was derived similarly to the LOAEL, from the next lowest concentration. The LOAEL exposure was 1,000ppm, and the next lowest exposure concentration was 100ppm. Using the same equation as used for the LOAEL, the NOAEL TRV would be: 100 mg/kg x 0.028 kg/day / 0.35 kg = 8 mg/kg bw/day. The alternative NOAEL TRV derived from this paper should be 8 mg/kg bw/day.
Vanadium	0.27 mg/kg bw/day	2.7 mg/kg bw/day	Adachi et al. (2000)	Figure 1a shows the selected LOAEL of 50 ppm, at which body weights were significantly reduced compared to the control. The BW of 0.267 is the average for the control derived from Figure 1a and the FIR of 0.0142 kg/day is derived from the control ingestion rates shown in Figure 1b. The LOAEL TRV was calculated as the concentration in the diet times the FIR divided by the BW (50 mg/kg x 0.0142 kg/day ÷ 0.267 kg = 2.7 mg/kg bw/day). The NOAEL is the LOAEL/10.	The TRVs selected from the cited paper were verified.
Total PCBs	80 µg/kg bw/day	96 µg/kg bw/day	Chapman (2003)	The LOAEL was derived from the interpolated dietary concentration resulting in a 25% decrease in endpoint response (1,000 µg/kg ww) and the NOAEL was derived from the interpolated dietary concentration resulting in a 10% decrease in endpoint response (1,100 µg/kg ww). A factor of 0.52 was applied to account for the lower effect levels observed in several studies that were conducted over 2 years or into the second generation (Brunstrom et al. 2001; Restum et al. 1998). This resulted in LOAEL and NOAEL dietary concentration of 500 and 600 µg/kg ww, respectively (applying two significant figures). The TRVs were derived using a body-weight normalized FIR of 0.16 kg/kg bw/day from Bleavins and Aulerich (1981). Note that this derivation description is provided in Section 9.1.3.2 of the BERA.	The TRVs selected from the cited paper were verified.

COPEC	NOAEL TRV from BERA	LOAEL from BERA	Reference[a]	Explanation of TRV Derivation[b]	EPA Comments
TEQ	2.6 ng/kg bw/day	8.8 ng/kg bw/day	Hochstein et al. (2001)	Table 1 presents the dietary concentration of 0.053 ppb (or 53 ng/kg) at which kit survival was decreased significantly compared to the control at 3 weeks. The average BW of 1.054 kg was derived from Table 4. The FIR of 0.1759 kg/d was derived from Bleavins and Aulerich (1981). The LOAEL TRV was calculated as the concentration in the diet times the FIR divided by the BW (53 ng/kg x 0.1759 kg/day ÷ 1.054 kg = 8.845 ng/kg bw/day). The NOAEL was derived similarly from the next lowest dietary concentration (0.016 ppb or 16 ng/kg) in the same study.	The TRVs selected from the cited paper were verified.

Notes:

[a] Complete citations for references cited in this column are presented in the BERA.

[b] Complete citations for references cited in this column are as follows:

Bleavins MR, Aulerich RJ. 1981. Feed consumption and food passage time in mink (*Mustela vison*) and European ferrets (*Mustela putorius furo*). Lab Anim Sci 31(3):268-269.

Brunström B, Lund BE, Bergman A, Asplund L, Athanassiadis I, Athanasiadou M, Jensen S, Örberg J. 2001. Reproductive toxicity in mink (*Mustela vison*) chronically exposed to environmentally relevant polychlorinated biphenyl concentrations. Environ Toxicol Chem 20(10):2318-2327.

Byron WR, Bierbower GW, Brouwer JB, Hansen WH. 1967. Pathologic changes in rats and dogs from two-year feeding of sodium arsenite or sodium arsenate. Toxicol Appl Pharmacol 10:132-147.

Heinz GH, Hoffman DJ, Krynitsky AJ, Weller DMG. 1987. Reproduction in mallards fed selenium. Environ Toxicol Chem 6:423-433.

Nagy KA. 2001. Food requirements of wild animals: predictive equations for free-living mammals, reptiles, and birds. Nutrition Abstracts and Reviews Series B: Livestock Feeds and Feeding 71(10):21R-31R.

NRC. 2005. Mineral tolerance of animals. Second revised ed. The National Academies Press, Committee on Minerals and Toxic Substances in Diets and Water for Animals, National Research Council, Washington, DC.

Restum JC, Bursian SJ, Giesy JP, Render JA, Helferich WG, Shipp EB, Verbrugge DA. 1998. Multigenerational study of the effects of consumption of PCB-contaminated carp from Saginaw Bay, Lake Huron, on mink. 1. Effects on mink reproduction, kit growth and survival, and selected biological parameters. J Toxicol Environ Health 54(A):343-375.

USEPA. 1988. Recommendations for and documentation of biological values for use in risk assessment. Publication 9345.0-10, EPA 600/6-87/008, NTIS PB88-179874/AS. US Environmental Protection Agency, Washington, DC.

Wobeser G, Nielsen NO, Schiefer B. 1976a. Mercury and mink I. The use of mercury contaminated fish as a food for ranch mink. Can J Comp Med 40:30-33.

BW – body weight
ERED – Environmental Residue Effects Database
FIR – food ingestion rate
LOAEL – lowest observed adverse effect level
NOAEL – no observed adverse effect level
PCB – polychlorinated biphenyl
TEQ – toxic equivalency factor
TRV – toxicity reference value